NISTTech

Real Time, Active Picometer-Scale Alignment, Stabilization & Registration in One or More Dimensions

Simple method to accurately position and stabilize microscopic structures

Description

Position and stabilize microscopic structures by attaching a fiducial mark to a sample and measuring the scattering of optical signals (e.g., as generated by a laser) off this mark. Align two or more in independent structures relative to each other, or relative to a shift of a known center, or raster scan structures with respect to each other.

A single laser beam can be used for the alignment, stabilization and registration of more than one structure. For example, one laser beam can measure the lens and the fiducial mark on the sample, or instead may be split to measure one fiducial mark on one sample, one fiducial mark on another sample (e.g., a mask), and the lens.

The signals are provided to a feedback processor to create an output related to the input signal from the photo-sensitive device. If the signals are not within a certain limit, then the position of at least one of the independent structures is varied such that the electrical signals are within the limits of the desired value. If the signal is within a desired threshold, the positioning remains unchanged. The laser light will be scattered off the two or more mechanically independent structures either continuously or within certain predefined intervals to ensure that the separation between the structures does not vary within predefined limits.

Note: Also see NIST docket 08-020, below under Citations.

Applications

- **Optics and microscopy**
  May be used in scanning probe microscopy, Atomic Force Microscopy (AFM) and optical microscopy
- **Semiconductors**
  Used in semiconductor patterning including semi-conductor wafer and mask alignment, and operating optical tweezers

Advantages

- **Decreases drift**
  Achieves accurate positioning and stabilization
- **Reduces or eliminates noise**

Abstract

In this disclosure, we present a widely applicable technique which enables two (or more) mechanically independent structures (e.g. an atomic force microscopy (AFM) tip and a reference mark on the sample substrate) whose respective positions in three dimensional space can be maintained with sub-nanometer precision for long (~100 s) periods of time. The method is based on the scattering of laser light by one (or more) fiducial marks. One mark is coupled to each structure to be positioned, except in the case where a lens is one of the structures to be stabilized. The scattered light is collected in a photo-sensitive device which enables real-time high-bandwidth position-sensing of each structure. The method requires one of the structures to be mounted onto a precision (e.g. piezoelectric) 2D or 3D translational stage. Signals generated by the scattered light field are used in a feedback loop to modulate the stage position. The technique presented here could potentially find utility across a number of disciplines including: optical tweezers, optical microscopy, scanning probe microscopy and semiconductor pattering and processing.

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Citations

1. NIST docket# 08-020

References

- U.S. Patent #7,928,409
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Status of Availability

This invention is available for licensing.

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